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Wrap-Up Report for 2019 Seoul Fuel Ethanol Conference

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Biofuels

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Report Highlights:
On April 30, 2019, U.S. Embassy Seoul's Office of Agricultural Affairs, the U.S. Grains Council (USGC) Korea office, and the Korea Biofuels Forum (KBF) jointly hosted the 2019 Seoul Fuel Ethanol Conference. Conference speakers provided information on the global ethanol trade, the positive impact on the environment and gasoline refinery economics of ethanol blending, and ethanol policy updates in neighboring countries, including Japan. The Korean government recently finished a feasibility study on ethanol blending in the transportation sector and this report is being reviewed by the Ministry of Trade, Industry and Energy which will finalize a recommendation on whether to permit ethanol fuel blends in the near future.

For the past four years, FAS Seoul and the U.S. Grains Council Korea office have hosted an annual ethanol conference to explain the environmental, human health, energy security, and economic benefits for Korea of blending ethanol into the gasoline supply. On April 30th, FAS Seoul, U.S. Grains Council Korea office, and the Korea Biofuels Forum (KBF) jointly hosted the fourth and largest iteration of this conference. Despite acknowledged air quality issues in urban centers, Korea does not currently allow the use of ethanol as a transportation fuel. With growing public concern about air quality issue in the transportation sector, the growing use of ethanol in transportation fuel in neighboring countries, and Korea's interest in diversifying energy sources, FAS Seoul is optimistic that Korea will soon move towards approval for some ethanol use in fuel.

The 2019 conference featured the following speakers and presentations:

1. Fuel Ethanol Policy and Supply & Demand in Neighboring Countries - Mr. Brian Healy

2. The Effect of Fuel Ethanol Blend on Fine Particulate Matters, Life Value and GHG Emission in Seoul - Dr. Steffen Mueller

3. The Future Trend and New Engine Technologies to Meet Emission Regulations - Dr. Ki Hyoung Lee

4. Economic Benefits of Fuel Ethanol Blend from the Oil Refinery Point of View: Octane Economic - Mr. Jody Hall

5. Background and Future Outlook of Japan's ETBE Policy - Dr. Shinya Yokoyama

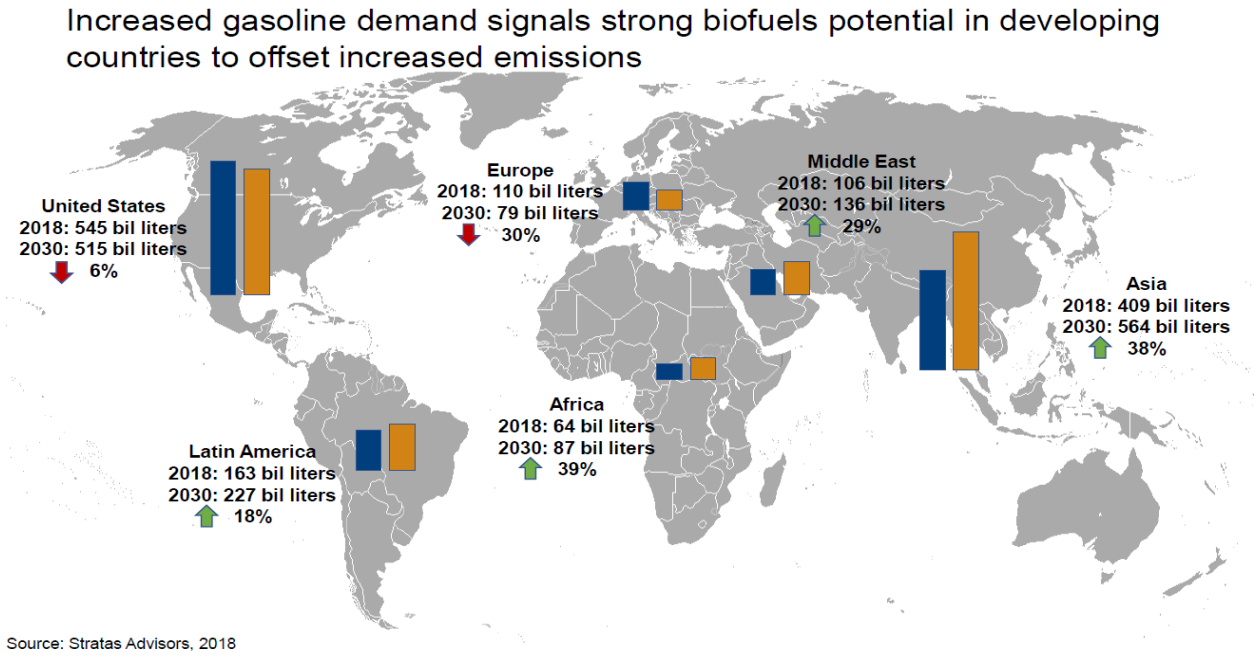
6. Panel Discussion: The Necessity of Korea's Fuel Ethanol Policy and Future Roadmap

- Dr. Ik Soo Kim, Chief Editor, the Environment Daily News: Moderator
- Dr. Jae-Kyung Kim, Director of Oil Policy Research Division, Korea Energy Economics Institute (KEEI)
- Ms. Hye Ran Hong, General Director, Korea NGO's Energy Network
- Dr. Jin-suk Lee, Director, Bioenergy R&D Center, Korea Institute of Energy Research
- Dr. Gi Eun Kim, Prof. Dept. of Biotechnology, Seokyeong University
- Dr. Lim, Eui-Soon, General Manager for R&D department for K-Petro

[Presentation #1: Fuel Ethanol Policy and Supply & Demand in Neighboring Countries]

Mr. Brian D. Healy, Manager of Ethanol Export Market Development / US Grains Council (USGC)

Countries who have enforced ethanol/biofuels/renewable content policies achieve environmental goals, human health benefits, and boost gasoline refinery economics and profitability. In 2018, more than 65 countries had biofuels policies in place. In the last two years, 13 countries have announced significant expansions to their policies. 2018 global ethanol trade set a record of 10.7 billion liters with the U.S. share of world exports expanding to 61%.
Global production surpassed 110 billion liters and is expanding due to policies that drive more ethanol demand. New policy developments over the last two years are in response to countries trying to meet 2015 Greenhouse Gas reduction commitments, which will further drive ethanol production and trade.
Increased gasoline demand in developing countries signals strong potential for biofuels to offset increased CO2 emissions.
With an eye toward 2030, future ethanol use trends include a growing role for its GHG emission reduction qualities, an increasing share of exports as a component of total production, the normalization of ethanol use in countries without production, and an equalization of tariffs that are in line with other energy sources.

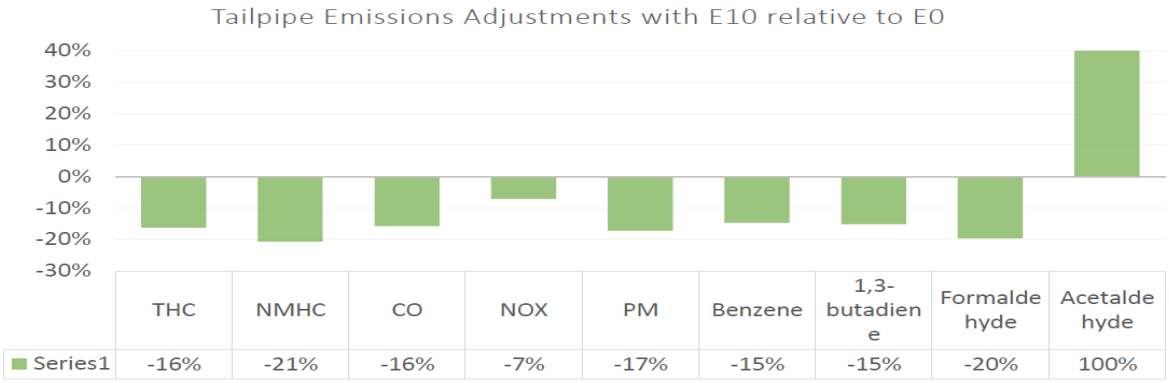


[Presentation #2: The Effect of Fuel Ethanol Blends on Fine Particulate Matter, Life Value, and GHG Emissions in Seoul, South Korea]

Dr. Stephan Mueller, Principal Research Economist, University of Illinois at Chicago (UIC)

THE UNIVERSITY OF ILLINOIS AT CHICAGO

Thorough Literature Review of Vehicle Emissions Studies with E10



Dr. Mueller presented updated data and analysis pertaining to last year's Five Cities Report, a University of Illinois at Chicago study on the impacts of ethanol on urban air quality in five major world cities, including Seoul. He also presented findings based on a literature review of available studies on the tail pipe emissions' impact of different ethanol blends. The review found broad agreement across the nearly 20 studies, the vast majority of which were conducted within the last ten years, that ethanol blends produce significant reductions in major air toxins, particulate matter, and carbon monoxide.

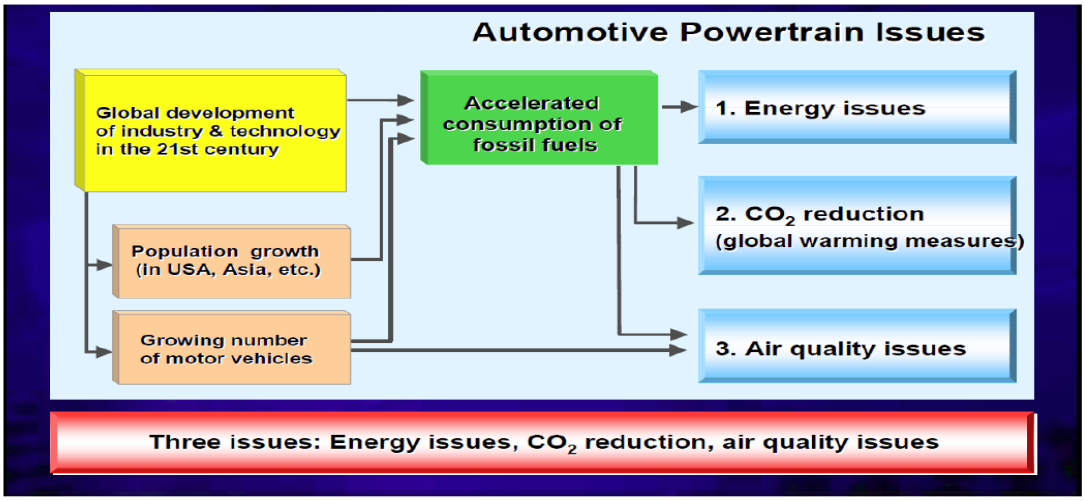
More specific to Seoul, Dr. Mueller's updated study found ethanol-blended fuel in Korea would reduce emissions of several pollutants, especially those classified as cancer-causing "toxic air contaminants". The reduction of these toxins would generate $223 million in years of life value saved. Dr. Mueller also provided updates to the analytical model that determines the greenhouse gas (GHG) savings provide by ethanol. Improvements in both corn yield and ethanol production facilities has meant that the GHG intensity of ethanol continues to fall, currently sitting at about half the intensity level of regular gasoline.

Presentation #3: Future Trend and New Engine Technologies to Meet Emission Regulations

Dr. Ki Hyung Lee, Dean of Engineering Sciences College / Hanyang University, Korea

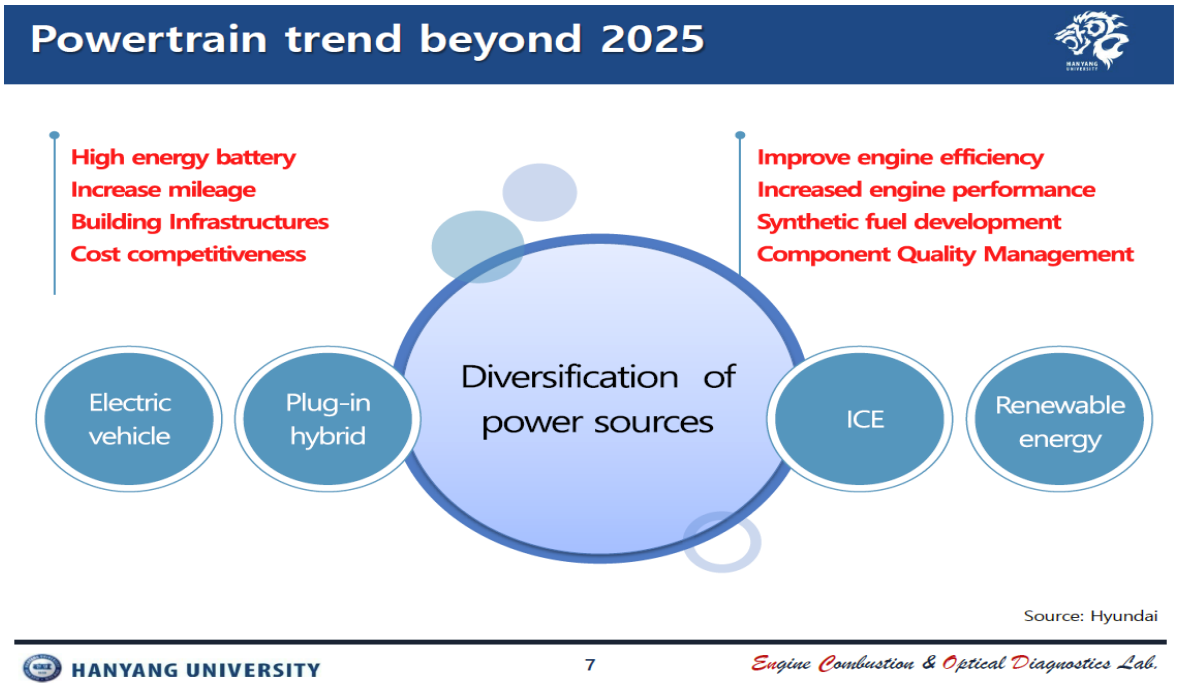
The future trend of engines will determine the use of ethanol up to 2030. The three issues that engine manufacturers must address in the next decade are: 1) the use of sustainable energy, 2) CO_2 reduction to prevent global warming, and 3) the air quality issue. The future of engines will depend on how much it can reduce the CO_2 , as well as exhaust emissions, such as NOx and particular materials (PM).

Awareness of Issues



Source : Toyota

In order to address these issues, engine manufacturers are trying to improve engine efficiency as well as diversify power sources, ranging from electric vehicle, plug-in hybrid, Fuel Cell Electric Vehicle (FCEV) and use of renewable energy sources, such as ethanol. Despite the introduction of these new type of engines, internal combustion engines that currently account for over 90 percent of the market share are expected to maintain over 75 percent of the total market share in 2030. As the total number of diesel engines continues to drop due to concerns over particulate matter, the gasoline engine is expected to make up for the drop in diesel engines, with new technologies being applied, such as lean burn technology, VCR, electrification, etc. Research work continues to find the optimum ratio of ethanol/gasoline blends. Hyundai Motors is planning to introduce an ethanol flexible engine in the fall of 2019 and Nissan has completed the development of variable compression ratio engine. When these new technologies are combined with other technology, such as miller cycle, variable valve system, new ignition system, and water injection technology, gasoline engines are expected to maintain a market share of 50 percent.



There is some speculation that diesel engines will disappear in 2030, but new technologies are expected to allow diesel engines to continue to be marketed in the future. Electric vehicles have been successful due to low battery costs, higher energy density, and government subsidy. However, the future of EV will depend heavily upon the future of battery prices and the availability of a government subsidy. The Fuel Cell Electric Vehicle (FCEV) has been moving ahead smoothly with the active support of the current administration in Korea but the future of FCEV depends on how fast hydrogen stations can be constructed throughout the nation.

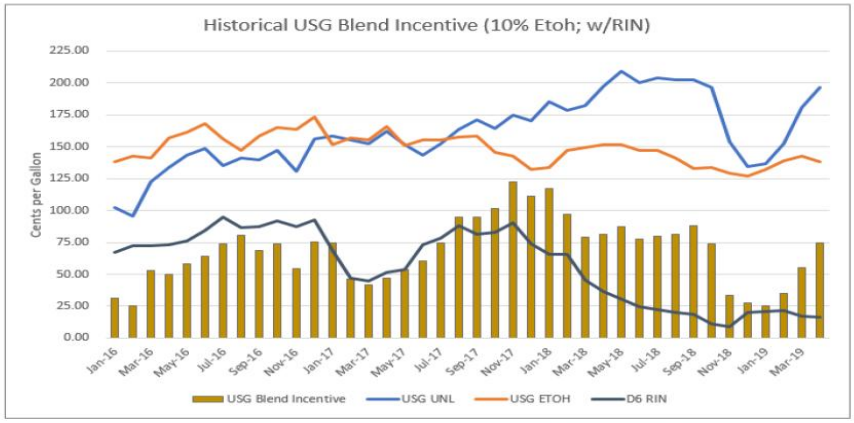
Presentation #4: Economic Benefits of Fuel Ethanol Blend from Oil Refinery Point of View (Octane Economy)

Mr. Jody Hall, Director for Global Ethanol Trading and Marketing / Flint Hills Resources

The United States produces approximately 16 billion gallons of ethanol annually, which is 58% of world production. U.S. ethanol production has continued to increase, while domestic demand has plateaued. U.S. ethanol will be available to help countries move toward their own biofuel mandates and to stem shortfalls in local production. Ethanol is blended with gasoline at a 10% rate in the United States and between 5% and 8% on average globally. Ethanol is a high octane, low sulfur, high oxygen blend component for gasoline. Refineries constrained on octane can create more salable gasoline by creating a blend stock for ethanol blending. Ethanol is a low cost source of octane. The U.S. renewable Fuel Standard (RFS) was created in 2005. There is a Renewable Volume Obligation (RVO) in which obligated parties are refiners or importers of gasoline or diesel fuel. The EPA establishes RVOs annually, and compliance is achieved by blending renewable fuels or by obtaining credits (RINs). RINs are generated when a producer makes a gallon of renewable fuel and can be traded between parties.

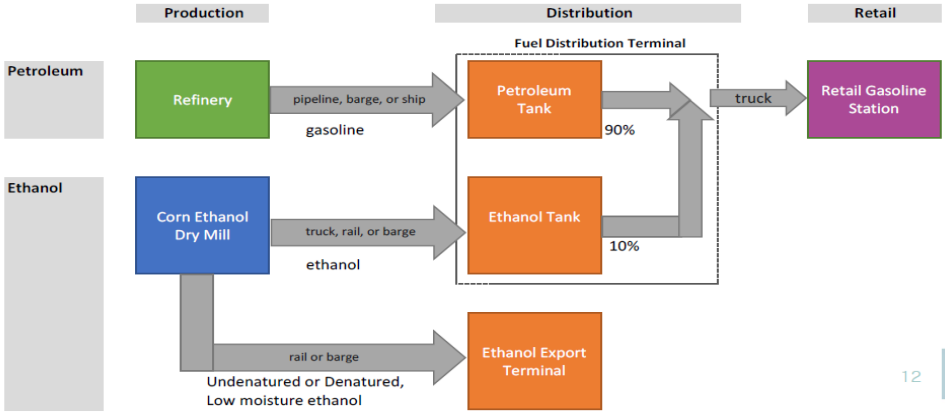
USGC Ethanol Blend Incentive

- Blend Incentive = (Gasoline – Ethanol) + RIN
- On average ethanol has provided an incentive of $.07/gallon over last 2 years
- If ethanol price is greater than gasoline then RIN value appreciates to incentives blending



U.S. Ethanol Distribution System

- Ethanol is added to petroleum close to the end consumer.
  - Ethanol's affinity for water will make the blend fail specifications if it comes in contact with water during distribution.
  - Ethanol plants are located near grain source.
  - Refiners are located near crude oil source.



[Presentation #5: Background and Future Outlook of Japan's ETBE Policy](#)
Dr. Shinya Yokoyama, Professor of Tottori University of Environmental Studies

Summary

In Japan, the introduction of bioethanol (830,000 kL), which is equivalent to 500,000 kL of gasoline, was enforced in 2011 from the viewpoint of energy security, energy efficiency and environmental consideration. Infrastructure was provided until 2017 to support the gradual increase of bioethanol. The blending rate was E3. However, ETBE was adopted instead of direct blending. This law was extended until 2023 after 7 years experience. The ethanol produced in Brazil is transferred to the United States to convert to ETBE and then transported to Japan.

It was decided by the law amendment in 2018 that the GHG reduction rate was revised upward from 50% to 55%. If the reduction rate (55%) can be satisfied by weight average, it would be possible to import ethanol from the USA as well as from Brazil.

R & D for novel technologies to produce transport fuels such as second generation ethanol and biojet fuels has been greatly encouraged and expected.

Dr. Shinya Yokoyama of Japan's Tottori University of Environmental Studies presented audience members with an overview of Japan's biofuels policy, noting the important role ethanol can play in reducing the greenhouse gas (GHG) footprint of a nation's transportation sector. Japan's bioethanol policy began in 2011, requiring the blending of 7% ETBE into its gasoline stock. ETBE is a fuel oxygenator that utilizes ethanol as a major component. Properties of ETBE are more similar to gasoline compared to pure ethanol but it requires additional processing. In Japan's case, Brazilian ethanol is shipped to the USA where it is processed into ETBE and then sent to Japan. The 7% blend mandate in Japan is comparable to an effective ethanol blend rate of 2%. The current feedstock policy for ethanol used in ETBE production is that it generates a minimum life cycle analysis (LCA) GHG reduction of 55%. Japan's current model credits Brazilian sugarcane ethanol with a 60% reduction and credits US corn ethanol with a 48% reduction. If the U.S. ethanol industry continues to increase efficiencies, it will be possible for their GHG reduction score to reach 55%, enabling it to qualify for use as a feedstock in Japan's biofuels program.

#6. Panel Discussion: The Necessity of Korea's Fuel Ethanol Policy and Future Roadmap

Ms. Hye Ran Hong, General Director, Korea NGO's Energy Network: This is the right time to publicize the biotech ethanol issue. The issue with fine dust became a national disaster and any tangible resolution should be made. However, although ROKG dedicated a lot of money to reduce fine dust, most money goes to scrap old cars and diesel vehicles. Only a small portion of the budget goes for the development of technologies to reduce air pollution. To diversify energy sources is an important thing to consider. It is critical for Korea to have political will in dealing with this issue and economic and environment factors should be considered in making policy. To do so, public awareness of this issue and a role of researchers and experts will be important.

Dr. Jin-suk Lee, Director, Bioenergy R&D Center, Korea Institute of Energy Research (KIER): Korea has been reviewing the introduction of (bioethanol) BE to Korea by benchmarking the Brazilian

situation. There are a couple of issues to introduce BE to Korea. One is the stability issue: will Korea have sufficient supply and how will price fluctuation be dealt with? The other issue is where Korea should start: straight ethanol blending or ETBE? The Korean Petroleum Management Institute has been doing a three-year research project on the feasibility of ETBE. Korea should start with ETBE and move to straight ethanol blending (E3) later to avoid any potential problem that may happen with straight ethanol blending.

Dr. Gi Eun Kim, Prof. Dept. of Biotechnology, Seokyeong University: Korea seems to focus on the effect of fine dust and it does not seem interested in the cause of fine dust. If the national policy focuses on just one issue, such a policy would have less effect. A long term reduction policy should be considered. For ethanol, we have to think about why it is important for the national economy. For a national energy policy, diversity and flexibility are important things to consider. For supply and demand of energy sources, price stability is important. We should have diversified solutions to deal with it and it is also important to reduce the rate of dependence of imports.

Dr. Lim, Eui-Soon, General Manager for R&D department for K-Petro: ethanol is necessary to diversify energy sources and to reduce harmful emission gases. However, there are a couple of hurdles to the introduction of ethanol in Korea—one is public perception and acceptance of the use of food grains to produce energy. There is also an economic issue—the domestic ethanol price is much higher than petroleum. If ethanol has economic benefits, then it may be used. To introduce ethanol, an in-depth review on how to introduce (whether straight blending or ETBE) should be completed by considering technical advantages/disadvantages of them. As it took over 17 years for biodiesel to be added to our energy source options after research and pilot programs, ethanol also needs to follow the same path, which requires various policy steps.

Dr. Jae-Kyung Kim, Director of Oil Policy Research Division, Korea Energy Economics Institute (KEEI): The countries on the mandatory ethanol blending system have plenty of domestic feedstock such as corn, sugarcane and cassava so they can produce bioethanol at a relatively cheaper price. However, Korea needs to consider the influence of gasoline price increases if bioethanol is blended into gasoline fuel. Korea also needs to think about the public acceptability for fuel ethanol since many people still point out the waste of food resources if we use foodstuffs (corn and sugarcane) for fuel production. It could be an obstacle for the introduction of a mandatory bioethanol blending system in Korea. On the other hand, the public acceptability can be increased if bioethanol is emphasized as a byproduct of feed (DDGs) production.

Mr. Brian D. Healy, Manager of Ethanol Export Market Development / US Grains Council (USGC): Korea is considering the introduction of fuel ethanol in the transportation sector and it can be a meaningful for the environment, economy and public health. If Korea takes the opportunity to receive technical information about fuel ethanol from Japan and the United States, it could result in big economic benefits for Korea.

Mr. Jody Hall, Director for Global Ethanol Trading and Marketing/Flint Hills Resources: Korea oil refiners may be uncomfortable with ethanol introduction during the transition period but they will soon adjust. In addition, fuel ethanol is not a silver bullet to resolve the air quality issue that Korea is facing at the moment but it could be a step forward for a better environment in the future.

Dr. Stephan Mueller, Principal Research Economist, University of Illinois at Chicago (UIC): Korea shouldn't focus exclusively on the volume reduction of PM2.5. The actual make up of that fine dust is also important, especially the more carcinogenic materials in the fine dust we breathe, which can easily be reduced by introducing an ethanol blend.